

# PATENT ABSTRACTS OF JAPAN

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(22)Date of filing : **03.03.1997** (72)Inventor : **KYO SEIKEN**

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(30)Priority

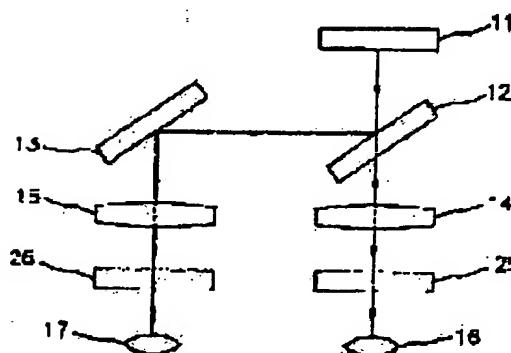
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## (54) HEAD-MOUNTED DISPLAY DEVICE

(57)Abstract:

**PROBLEM TO BE SOLVED:** To reduce the weight and to simplify the circuit of a display device by providing first and second magnification lenses arranged between a light separating means and one eye of an observer and between a reflecting mirror and the other eye of the observer.



**SOLUTION:** A beam splitter 12 is arranged between a video display device 11 and a right eye 16 to transmit a half of light from the device 11 and to reflect the other half in the ratio of 1:1 to separate into two light beams. Provided with first and second shutter glasses 25 and 26 respectively arranged between a first magnification lens 14 and the right eye 16 and between a second magnification lens 15 and the left eye 17, the device 11 alternately displays video for the right eye and video for left eye. The glasses 25 and 26 are synchronized with the video for the right eyes and the left eyes of the device 11 to be alternately transparent and opaque to allow the observer to see three-dimensional video.

## LEGAL STATUS

[Date of request for examination]

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[Date of final disposal for application]

[Patent number]

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## CLAIMS

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[Claim(s)]

[Claim 1] the light from one image display device and said image display device is divided into two light beams -- making -- said light beam -- with an optical separation means to carry out incidence of inner one side to one eye of a watcher The reflective mirror which turns to the eye of said watcher's another side another side of the light beams separated by said optical separation means, and is reflected, Head-mounted display equipment characterized by having the 1st and 2nd magnifying lenses respectively arranged between said optical separation means and one [ said ] eyes of said watcher, and between said reflective mirrors and eyes of said another side of said watcher.

[Claim 2] Said optical separation means is head-mounted display equipment according to claim 1 characterized by consisting the light from said image display device of partial transparency and a beam splitter which carries out partial reflection.

[Claim 3] It has further the 1st and 2nd shutter glass respectively arranged between said 1st magnifying lens and one [ said ] eyes of said watcher, and between said 2nd magnifying lens and eyes of said another side of said watcher. Said image display device displays by turns the

image for right eyes and the image for left-hand side eyes which were photoed from the include angle which is different from each other. Said 1st and 2nd shutter glass is head-mounted display equipment according to claim 1 characterized by making said watcher visible [ by turns / in a 3D scenography ] synchronizing with the object for the right eyes of said image display device, and the image for left eyes transparency and by supposing that it is opaque.

[Claim 4] Said 1st and 2nd shutter glass is head-mounted display equipment according to claim 3 characterized by being manufactured by the liquid crystal matter.

[Claim 5] One image display device and a means to make the light from said image display device divide into two light beams, the light beam separated by said optical separation means – with the reflective mirror in which inner one side is reflected The 1st and 2nd half mirrors which reflect respectively the light beam of another side of the light separated by said optical separation means, and the light beam reflected by said reflective mirror, Head-mounted display equipment characterized by having the 1st and 2nd concave reflective mirror which turns respectively the light beam from said 1st and 2nd half mirrors to one eye of a watcher and the eye of another side, and is reflected.

[Claim 6] Said optical separation means is head-mounted display equipment according to claim 5 characterized by consisting the light from said image display device of partial transparency and a beam splitter which carries out partial reflection.

[Claim 7] It has further the 1st and 2nd shutter glass respectively arranged between said 1st half mirror and one [ said ] eyes of said watcher, and between said 2nd half mirror and eyes of said another side of said watcher. Said image display device displays by turns the image for right eyes and the image for left eyes which were photoed from the include angle which is different from each other. Said 1st and 2nd shutter glass is head-mounted display equipment according to claim 5 characterized by making said watcher visible [ by turns / in a 3D scenography ] synchronizing with the object for the right eyes of said image display device, and the image for left eyes transparency and by supposing that it is opaque.

[Claim 8] Said 1st and 2nd shutter glass is head-mounted display equipment according to claim 7 characterized by being manufactured by the liquid crystal matter.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] Especially this invention relates to the head-mounted display equipment which has one image display device about head-mounted display equipment (HEAD-MOUNTED DISPLAY APPARATUS).

[0002]

[Description of the Prior Art] The rough diagram of conventional head-mounted display equipment which has the image display devices (for example, LCD) 1 and 2 of a pair and the magnifying lenses 3 and 4 of a pair is shown in drawing 1.

[0003] It is arranged respectively at the front of a watcher's left eye and right eyes 5 and 6, it connects with a video-signal source of supply (not shown), and the image display devices 1 and 2 of a pair display an image with the video signal from them.

[0004] Magnifying lenses 3 and 4 are arranged between the left eye of the image display devices 1 and 2 and a watcher, and right eyes 5 and 6, and a watcher is made visible [ magnifying lenses ] in the expansion image formed in the place where only fixed distance was isolated from the eye.

[0005] However, since two image display devices exist and such conventional head-mounted display equipment is fairly heavy, it has given the burden to a watcher's head. Moreover, the circuit for transmitting a video signal to each image display device becomes complicated.

[0006]

[Problem(s) to be Solved by the Invention] Therefore, the main purposes of this invention are offering the head-mounted display equipment with which weight's decreases and a circuit's is simplified by having only one image display device.

[0007]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, according to one example of this invention, one image display device, the light from said image display device is divided into two light beams -- making -- said light beam -- with an optical separation means to carry out incidence of inner one side to one eye of a watcher. The reflective mirror which turns to the eye of said watcher's another side another side of the light beams separated by said optical separation means, and is reflected. The head-mounted display equipment characterized by having the 1st and 2nd magnifying lenses respectively arranged between said optical separation means and one [ said ] eyes of said watcher and between said reflective mirrors and eyes of said another side of said watcher is offered.

[0008] According to other examples of this invention, one image display device, A means to make the light from said image display device divide into two light beams, the light beam separated by said optical separation means -- with the reflective mirror in which inner one side is reflected. The 1st and 2nd half mirrors which reflect respectively the light beam of another side of the light separated by said optical separation means, and the light beam reflected by said reflective mirror. The head-mounted display equipment characterized by having the 1st and 2nd concave reflective mirror which turns respectively the light beam from said 1st and 2nd half mirrors to one eye of a watcher and the eye of another side, and is reflected is offered.

[0009]

[Embodiment of the Invention] Hereafter, it explains in more detail, referring to a drawing about the suitable example of this invention. The same reference mark expresses the same element with a drawing. The rough mimetic diagram and perspective view of head-mounted display equipment by one example of this invention are respectively shown in drawing 2 and drawing 3. The head-mounted display equipment by the 1st example of this invention contains partial transparency and the beam splitter 12 which carries out partial reflection, the reflective mirror 13, and the 1st and 2nd magnifying lenses 14 and 15 for the light from the image display device (for example, LCD or CRT) 11 and the image display device 11.

[0010] It is arranged in front of a watcher 16, for example, a right-hand side eye, it connects with video-signal sources of supply (not shown), such as PC, VCR, or LDP, and the image display device 11 mentioned above displays an image with the video signal from them.

[0011] A beam splitter 12 is arranged between the image display device 11 and the right-hand side eye 16, and is divided into two light beams by \*\*\*\*\*-half-reflecting the light from the image display device 11 by the ratio of 1:1. Incidence of the one light beam is carried out to a right eye 16 through a beam splitter 12, and after incidence of other light beams is carried out to the reflective mirror 13 arranged in front of a watcher's left eye 17, total reflection of them is carried out by the reflective mirror 13 towards a left eye 17.

[0012] The 1st and 2nd magnifying lenses 14 and 15 are respectively located between a beam splitter 12 and a right eye 16 and between the reflective mirror 13 and a left eye 17, and a watcher is made visible [ the magnifying lenses ] in the expansion image formed in the place where only fixed distance was isolated from the eye.

[0013] The head-mounted display equipment of this invention can offer 3-dimensional scenography by displaying an image display device again based on the principle of the

parallax (binocular parallax) of both eyes.

[0014] The rough diagram and perspective view of head-mounted display equipment by other examples of this invention which offers 3-dimensional scenography respectively are shown in drawing 4 and drawing 5. When the head-mounted display equipment by the 2nd example of this invention is compared with the 1st example, it has further the 1st and 2nd shutter glasses 25 and 26 respectively arranged between the 1st magnifying lens 14 and a right eye 16 and between the 2nd magnifying lens 15 and a left eye 17, and the image display unit 11 displays by turns the image for right eyes and the image for left eyes which were photoed from the direction or include angle which is mutually different. A watcher is made visible [ the 1st and 2nd shutter glasses 25 and 26 / by turns / in a 3D scenography ] synchronizing with the object for the right eyes of an image display device, and the image for left eyes transparency and by supposing that it is opaque. The 1st and 2nd shutter glasses 25 and 26 are manufactured by the liquid crystal matter (liquid crystal material) as indicated by United States patent No. 4,907,860 and No. 5,539,423 at the detail.

[0015] Moreover, the outline perspective view of the head-mounted display equipment by the 3rd example of this invention is shown in drawing 6. The head-mounted display equipment by the 3rd example of this invention contains partial transparency and the beam splitter 12 which carries out partial reflection, the reflective mirror 13, the 1st and 2nd half mirrors 19 and 20, and the 1st and 2nd concave reflective mirrors 21 and 22 for the light from one image display device 11 and image display device 11.

[0016] The image display device 11 is arranged at a watcher, for example, the front top of a right eye 16, and a beam splitter 12 is arranged under it. Moreover, the reflective mirror 13 is arranged on the left-hand side of a watcher in the same height as a beam splitter 12.

[0017] The 1st and 2nd half mirrors 19 and 20 are arranged so that it may correspond to a watcher's right eye and left eyes 16 and 17 under a beam splitter 12 and the reflective mirror 13 respectively. Moreover, the 1st and 2nd concave reflective mirrors 21 and 22 are arranged respectively at a 1st and 2nd half mirrors' reflection side.

[0018] a beam splitter 12 -- the light from the image display device 11 -- the ratio of 1:1 -- half-transparency -- and it is made to half-reflect The 1st half mirror 19 reflects the light from a beam splitter 12 by the 1st concave reflective mirror 21, and incidence of the light from the 1st concave reflective mirror 21 is carried out to a right eye 16 through the 1st half mirror 19.

[0019] On the other hand, the reflective mirror 13 turns and carries out total reflection of the light reflected by the beam splitter 12 to the 2nd half mirror 20. The 2nd half mirror 20 makes the 2nd concave reflective mirror 22 turn and reflect the light from the reflective mirror 13, and incidence of the light from the 2nd concave reflective mirror 22 is carried out to a left eye 17 through the 2nd half mirror 20.

[0020] Moreover, the rough perspective view of the head-mounted display equipment by the 4th example of this invention which offers 3-dimensional scenography is shown in drawing 7. When comparing the 4th example of this invention with the 3rd example, the image display unit 11 displays in alternation the image for right-hand side eyes and the image for left-hand side eyes which were mutually photoed from the direction or include angle of a difference, including further the 1st and 2nd shutter glasses 25 and 26 respectively arranged between the 1st half mirror 19 and a right eye 16 and between the 2nd half mirror 20 and a left eye 17.

[0021] A watcher is made visible [ the 1st and 2nd shutter glasses 25 and 26 / by turns / in a 3D scenography ] synchronizing with the object for right eyes and the image for left eyes which are displayed on an image display device transparency and by being made opaque.

[0022] In the above, although the specific example of this invention was explained, as for this contractor, it is needless to say that various modification can be added, without deviating from the claim indicated on these specifications.

[0023]

[Effect of the Invention] Therefore, according to this invention, in the head-mounted display equipment of this invention, since only one image display device is required, the burden which the weight decreases and is added to a watcher's head decreases. Moreover, the circuit for transmitting a video signal to an image display device can be simplified more.

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## TECHNICAL FIELD

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[Field of the Invention] Especially this invention relates to the head-mounted display equipment which has one image display device about head-mounted display equipment (HEAD-MOUNTED DISPLAY APPARATUS).

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## PRIOR ART

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## EFFECT OF THE INVENTION

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## EFFECT OF THE INVENTION

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## MEANS

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[Means for Solving the Problem] In order to attain the above-mentioned purpose, according to one example of this invention, one image display device, the light from said image display device is divided into two light beams -- making -- said light beam -- with an optical separation means to carry out incidence of inner one side to one eye of a watcher. The reflective mirror which turns to the eye of said watcher's another side another side of the light beams separated by said optical separation means, and is reflected. The head-mounted display equipment characterized by having the 1st and 2nd magnifying lenses respectively arranged between said optical separation means and one [ said ] eyes of said watcher and between said reflective mirrors and eyes of said another side of said watcher is offered.

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this invention is compared with the 1st example, it has further the 1st and 2nd shutter glasses 25 and 26 respectively arranged between the 1st magnifying lens 14 and a right eye 16 and between the 2nd magnifying lens 15 and a left eye 17, and the image display unit 11 displays by turns the image for right eyes and the image for left eyes which were photoed from the direction or include angle which is mutually different. A watcher is made visible [ the 1st and 2nd shutter glasses 25 and 26 / by turns / in a 3D scenography ] synchronizing with the object for the right eyes of an image display device, and the image for left eyes transparency and by supposing that it is opaque. The 1st and 2nd shutter glasses 25 and 26 are manufactured by the liquid crystal matter (liquid crystal material) as indicated by United States patent No. 4,907,860 and No. 5,539,423 at the detail.

[0015] Moreover, the outline perspective view of the head-mounted display equipment by the 3rd example of this invention is shown in drawing 6. The head-mounted display equipment by the 3rd example of this invention contains partial transparency and the beam splitter 12 which carries out partial reflection, the reflective mirror 13, the 1st and 2nd half mirrors 19 and 20, and the 1st and 2nd concave reflective mirrors 21 and 22 for the light from one image display device 11 and image display device 11.

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[0019] On the other hand, the reflective mirror 13 turns and carries out total reflection of the light reflected by the beam splitter 12 to the 2nd half mirror 20. The 2nd half mirror 20 makes the 2nd concave reflective mirror 22 turn and reflect the light from the reflective mirror 13, and incidence of the light from the 2nd concave reflective mirror 22 is carried out to a left eye 17 through the 2nd half mirror 20.

[0020] Moreover, the rough perspective view of the head-mounted display equipment by the 4th example of this invention which offers 3-dimensional scenography is shown in drawing 7. When comparing the 4th example of this invention with the 3rd example, the image display unit 11 displays in alternation the image for right-hand side eyes and the image for left-hand side eyes which were mutually photoed from the direction or include angle of a difference, including further the 1st and 2nd shutter glasses 25 and 26 respectively arranged between the 1st half mirror 19 and a right eye 16 and between the 2nd half mirror 20 and a left eye 17.

[0021] A watcher is made visible [ the 1st and 2nd shutter glasses 25 and 26 / by turns / in a 3D scenography ] synchronizing with the object for right eyes and the image for left eyes which are displayed on an image display device transparency and by being made opaque.

[0022] In the above, although the specific example of this invention was explained, as for this contractor, it is needless to say that various modification can be added, without deviating from the claim indicated on these specifications.

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## DESCRIPTION OF DRAWINGS

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### [Brief Description of the Drawings]

[Drawing 1] The rough mimetic diagram of conventional head-mounted display equipment.

[Drawing 2] The rough mimetic diagram of the head-mounted display equipment by one example of this invention.

[Drawing 3] The rough perspective view of the head-mounted display equipment by one example of this invention.

[Drawing 4] The rough mimetic diagram of the head-mounted display equipment by other examples of this invention.

[Drawing 5] The rough perspective view of the head-mounted display equipment by other examples of this invention.

[Drawing 6] The rough perspective view of the head-mounted display equipment by the 3rd example of this invention.

[Drawing 7] The rough perspective view of the head-mounted display equipment by the 4th example of this invention.

### [Description of Notations]

11 Image Display Unit

12 Beam Splitter

13 Reflective Mirror

14 1st Magnifying Lens

15 2nd Magnifying Lens

19 1st Half Mirror

20 2nd Half Mirror

21 1st Concave Reflective Mirror

22 2nd Concave Reflective Mirror

25 1st Shutter Glass

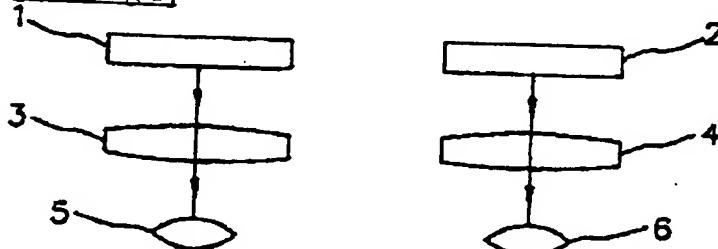
26 2nd Shutter Glass

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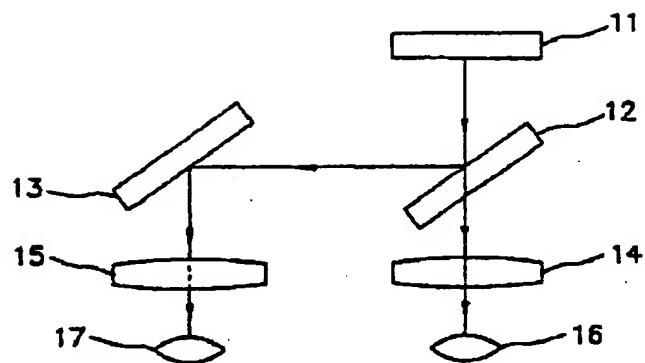
## DRAWINGS

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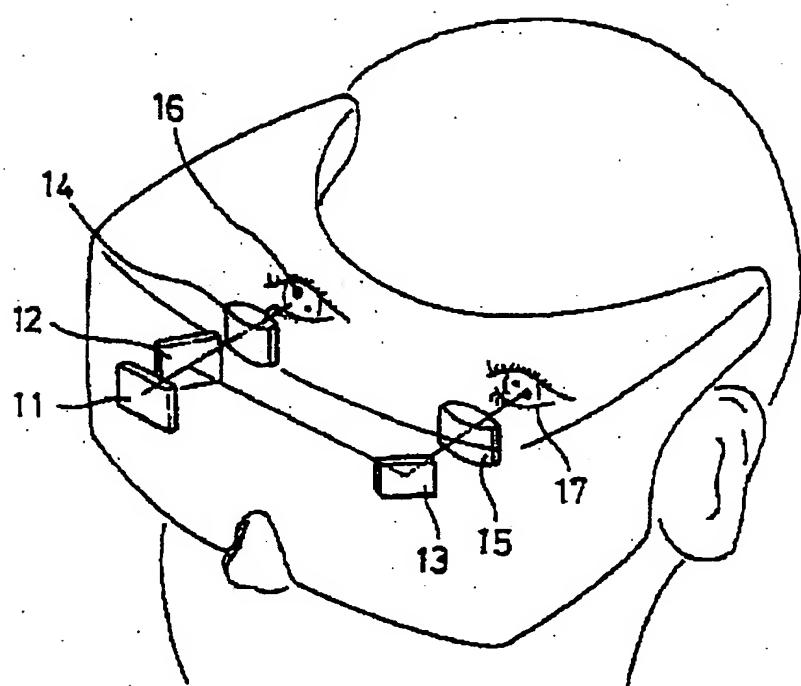
### [Drawing 1]



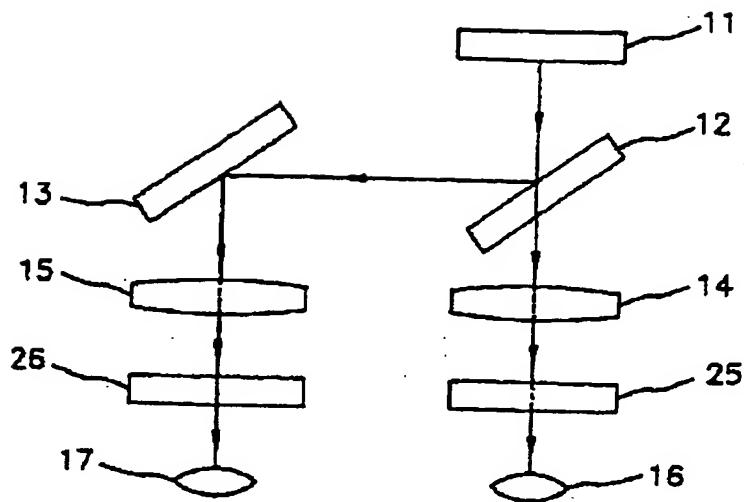
[Drawing 2]



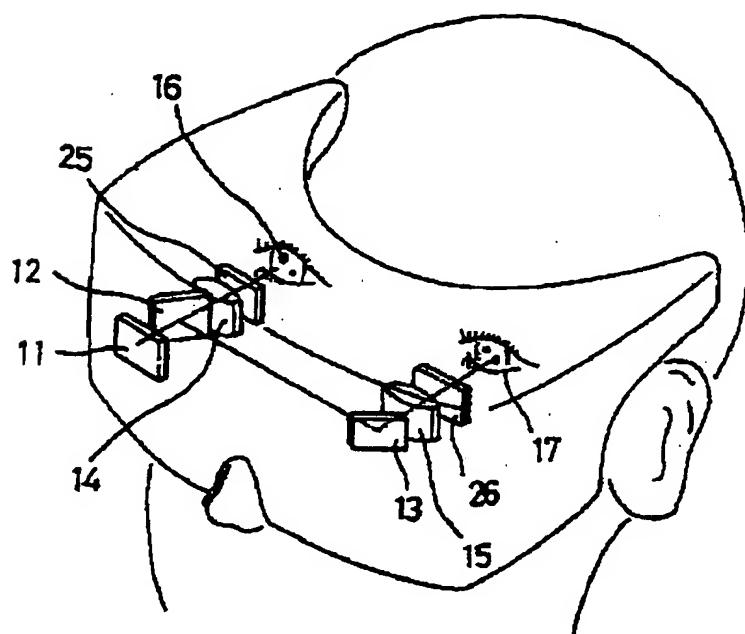
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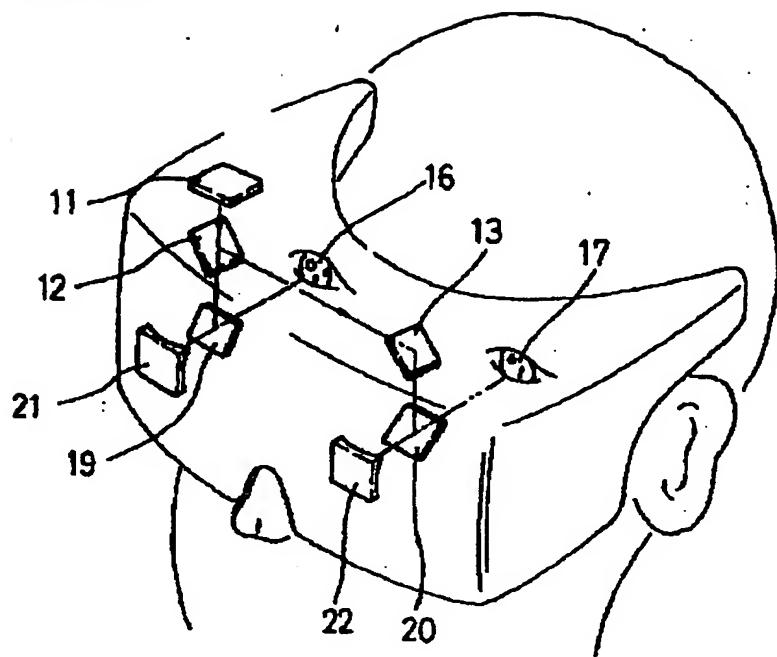
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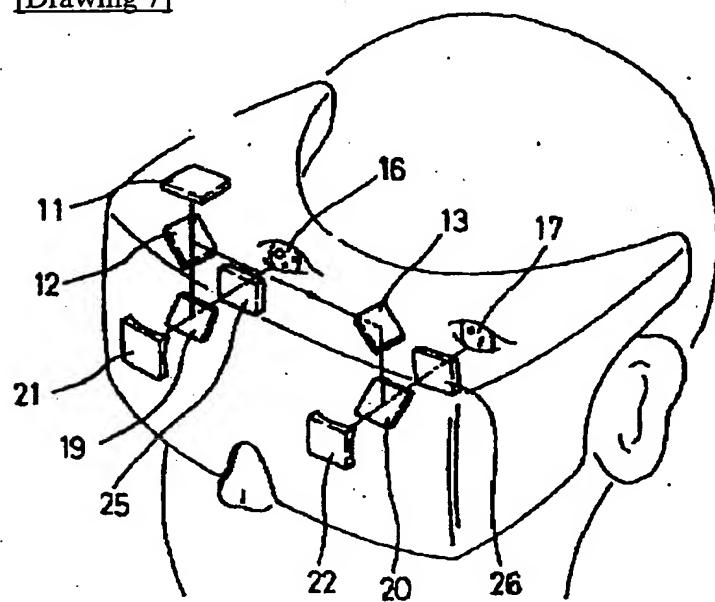
[Drawing 5]



[Drawing 6]



[Drawing 7]



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